SEA GRANT IN CALIFORNIA
Promoting Coastal Ocean Science and Education

California Sea Grant College
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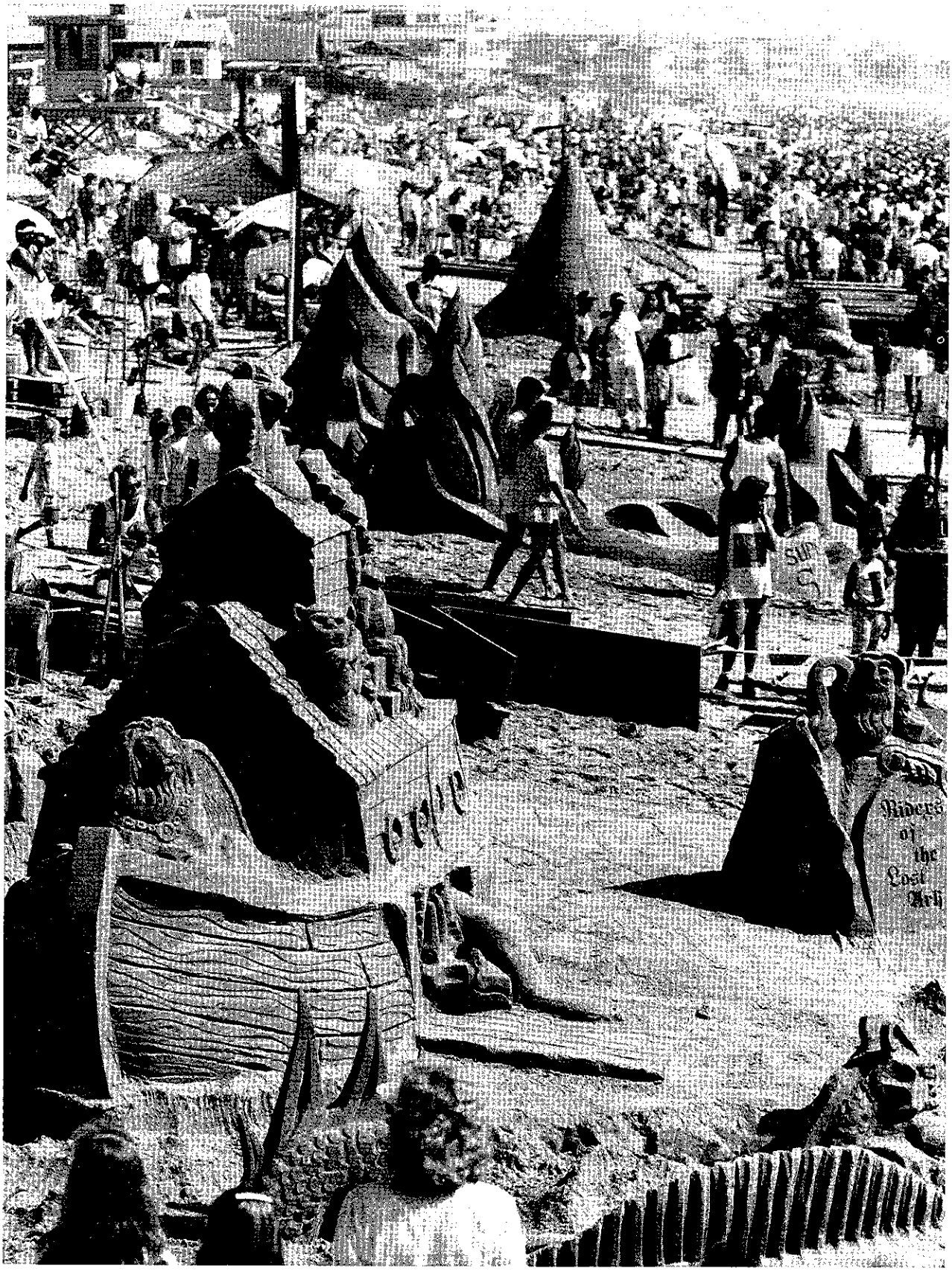


San Diego Union-Tribune

The continuing growth in California's population is placing great stress on coastal and ocean resources.

Introduction

This year—1993—is a banner year for Sea Grant in California.

Twenty years ago, the University of California was designated a Sea Grant College. This designation symbolized a mutual recognition of continuing responsibility, both by the U.S. Department of Commerce and the University of California, to "develop and maintain the excellence and public utility" of the Sea Grant program.

Also, in 1973, the state became a partner in the Sea Grant program with the federal government and with California's great university systems by enacting legislation to provide matching funds to California Sea Grant. That same legislation established an advisory panel, the Resources Agency Sea Grant Advisory Panel (RASGAP), to identify state needs that might be met through Sea Grant.

Today the national Sea Grant network, part of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, comprises 29 programs in the coastal and Great Lakes states. Of these, the California Sea Grant College is the largest, with a proven record of high productivity in marine science and technology. Together with the University of Southern California Institutional Sea Grant Program, it addresses a variety of marine-related problems and opportunities that are important to the state and the nation.

It is as part of our accountability to the citizens of California and the nation that we offer this report covering the fiscal period 1987-1992. In it we feature a selection of program activities that emphasize Sea Grant's accomplishments. A complete list of research projects conducted during this period appears on page 32.

Three broad areas of activity lie at the core of Sea Grant: research, extension, and education.

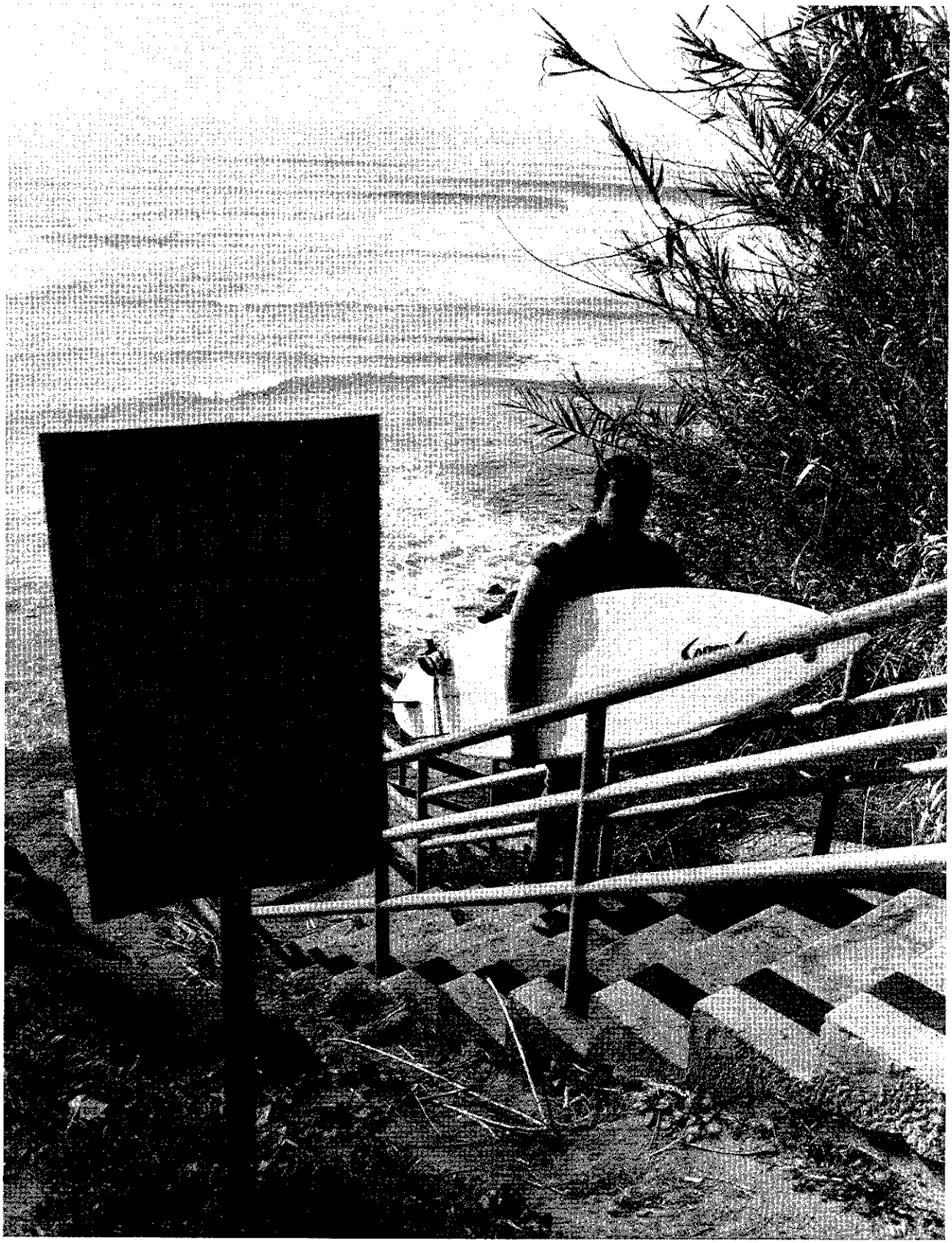
Through the application-oriented research that it sponsors, Sea Grant helps to improve the effectiveness of our academic institutions in addressing issues of concern to industry and to society.

Through the Extension Program, Sea Grant's marine advisors and specialists facilitate the flow of information between university-based researchers and a broad clientele that includes industry, government, and the public.

Lastly, through its support of education, particularly graduate education, Sea Grant invests in the future by producing a highly educated work force that produces important economic returns to the state and the nation.

As this report will illustrate, Sea Grant is an innovative program that fills a unique niche in American marine science. It is making major contributions to the marine economy, to a skilled labor force, to scientific achievement, to technology transfer, and to public education on critical resource and environmental issues.

James J. Sullivan
Director
California Sea Grant College



Bob Grieser/Los Angeles Times

Water quality affects not only recreational opportunities, but the aquaculture and fisheries industries as well. California Sea Grant scientists are exploring methods of detecting pathogenic bacteria and viruses in coastal waters, as well as determining the release rates of trace metals from contaminated sediments.

Using Molecular Technology to Identify Pollutants

Of the more than 2,000 U.S. beach closures in 1991 resulting from bacterial pollution, 745 occurred in California, according to a study conducted by a major environmental group.

The same group further explains that closures do not necessarily imply that coastal waters are more polluted in California than in other areas, but may reflect the fact that California has a better monitoring program. In fact, water monitoring in Southern California generally ranks among the best in the nation. Ten states, as well as some California counties, do not even test waters regularly for contamination because of the time and cost involved.

According to David Chapman and Clifford Brunk of UC Los Angeles, even where monitoring is done regularly, current methods are so crude and incomplete that they don't even come close to providing sufficient information for complete safeguarding of the public from different bacterial pollutions.

With support from the California Sea Grant College, the two scientists and their trainee are developing advanced molecular techniques for detecting and monitoring bacteria in a much more efficient and cost-effective manner. These techniques can be used to monitor essentially any contamination introduced from sewage overflows, storm drains, inadequate sewage treatment, and water runoff from farms and industrial sites.

By targeting the differences in specific genes common to all bacteria, the researchers are able to distinguish between different types of bacteria. "By using novel molecular techniques, we can extract bacterial DNA from seawater samples and develop a complete profile of different groups of bacteria present—whether natural or introduced—and their relative abundances in the sample," Chapman says.

This technique will provide data that every local, state, and federal agency charged with monitoring pollution and establishing policy and mitigation measures must have.

Thus far, the researchers have developed characteristic profiles at different times of the year for different locations in Santa Monica Bay (e.g., Hyperion sewage effluent and Ballona Creek). "Subtracting the profile of an unpolluted sample from the profile of a contaminated sample reveals peaks corresponding to the bacterial contamination," Brunk explains.

All the generated profiles are stored as computer files and can be readily compared with any other profile to determine changes and sources of bacterial populations. The researchers plan to monitor what happens to contaminated discharges: How far do the microorganisms disperse from the discharge points? How long do they survive?

"This technique, which utilizes a new technological development called capillary gel electrophoresis, provides a very powerful way to determine what different types of bacteria are in our coastal waters," Chapman says. "It will provide data that every local, state, and federal agency charged with monitoring pollution and establishing policy and mitigation measures must have."

Tracking Sediment Release of Trace Metals

These findings represent a significant beginning to predicting the fate of metal pollutants in the marine environment.

Many of the toxic metals that enter our bays and harbors end up contaminating the bottom sediments. Whether or not they will become an environmental threat to living organisms depends on whether they stay in the sediment or become soluble and move back into the seawater.

In a project sponsored by California Sea Grant, Clare Reimers, then with UC San Diego's Scripps Institution of Oceanography, conducted a pilot study to determine release rates of trace metals from contaminated sediments near Shelter Island in San Diego Bay. She also sought to determine how sensitive release rates are to a number of natural conditions, such as the sediment's pH, its dissolved oxygen and hydrogen sulfide content, and its electrical resistivity.

The study employed a state-of-the-art instrument called a "benthic flux sampling device," developed by the Naval Command Control, and Ocean Surveillance Center in San Diego. D. Bart Chadwick from the Center led the Navy's cooperative effort.

This device, new to environmental assessment work, isolates a volume of water above the sediment. Samples of this water are then taken over time to determine changes in the concentration of pollutants (and nutrients) of interest. Continuous measurements of the isolated water's temperature, salinity, pH, and dissolved oxygen are also made during each deployment.

Preliminary analysis of the results of two deployment series suggests that San Diego Bay sediments may steadily release manganese, zinc, and nickel, but take up copper. Analyses also suggest that there is little movement of cadmium and lead. Iron fluxes could not be determined because of sample contamination problems.

It has been suggested that oxygen is required for trace metals to be released from coastal sediments. This study did document with *in situ* microelectrode measurements that oxygen is present in the top centimeter of sediments, but that it is readily consumed by living organisms and by reactions involving reduced products of anaerobic respiration in this surface layer.

"This work reinforces the argument that the environmental risk of contaminated sediments cannot be based on the concentrations of pollutants in the sediments," Reimers says, "but rather on what gets back into the water. We need to know more about what environmental conditions cause natural variability in exchange rates and direction. Nonetheless, these findings represent a significant beginning to predicting the fate of metal pollutants in the marine environment."

Nearshore Investigations of Sewage Effluents

Ocean outfall systems form a plume of effluent in the marine environment, which is eventually diffused and dispersed in waters and sediments in a large field from the outfall terminus.

In a unique interdisciplinary effort, scientists funded by the University of Southern California Sea Grant Program are studying the complex coastal ocean processes at White's Point on the Palos Verdes peninsula, where a large marine outfall disperses an average of 400 million gallons of effluent each day.

Three USC biologists, Jed Fuhrman, Rodolfo Iturriaga, and Hiroki Shizuya, are exploring methods of detecting and counting pathogenic bacteria and viruses in coastal waters. Iturriaga has accomplished the testing of immunoproducts for direct detection of *Salmonella*, a human pathogen. Shizuya has been able to identify differences in DNA fragments and proteins in species of *Vibrio*, another pathogen. And Fuhrman has exposed a model virus to seawater and light and then measured its survivability to see how rapidly human viruses degrade in the marine environment. Eventually, these scientists will be able to describe the survivability and distribution of specific pathogens and their potential effects on natural and human populations.

Burton Jones at the USC Hancock Institute, with his collaborators, Libe Washburn at UC Santa Barbara and Tom Dickey of the Ocean Physics Group at USC, are exploring the oceanographic characteristics of large marine outfalls. These scientists are measuring dispersal of particulates from the White's Point Outfall and developing plume dispersion models for various conditions of current, wind, and tide.

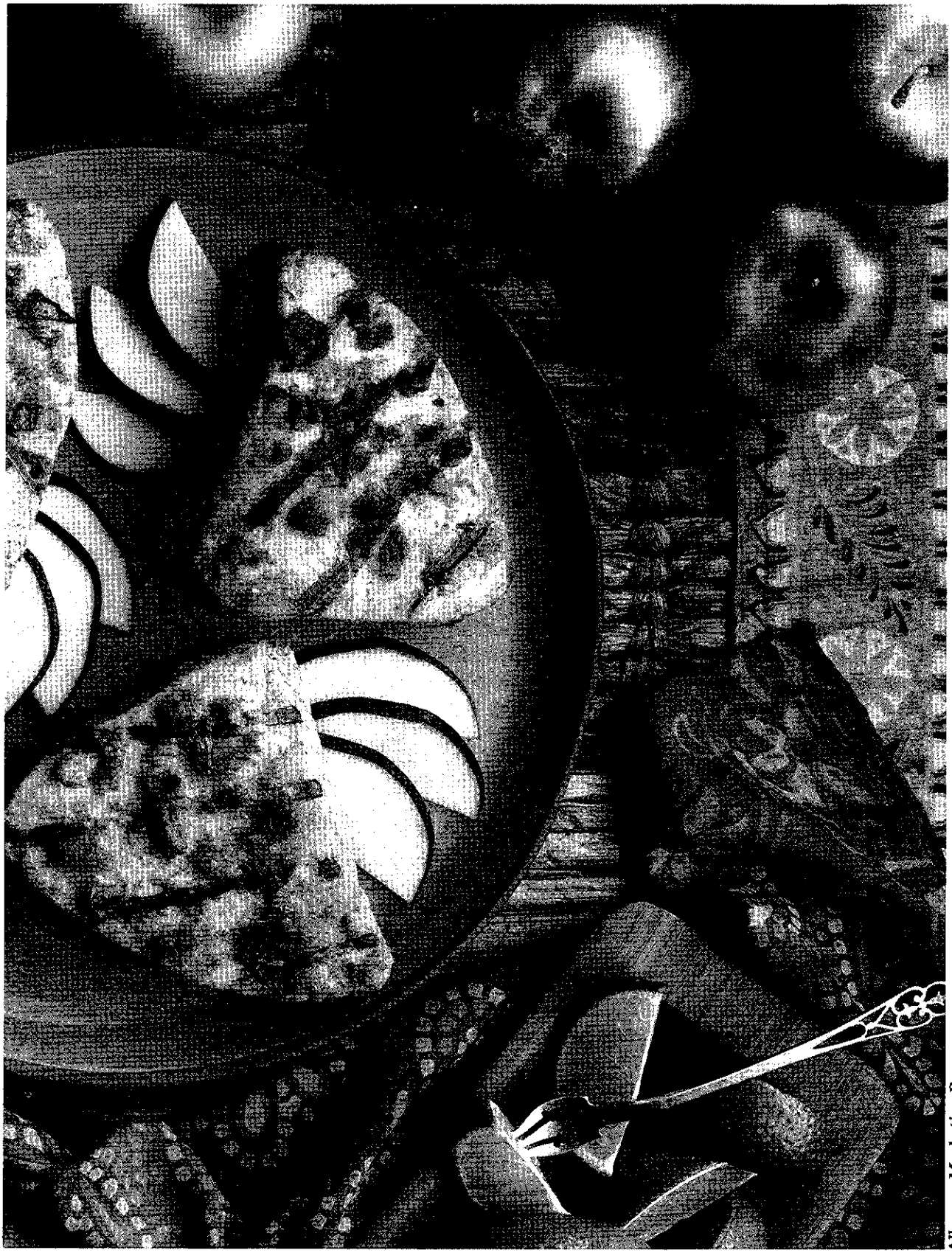
Scientists are studying the complex coastal ocean processes at White's Point on the Palos Verdes peninsula, where a large marine outfall disperses an average of 400 million gallons of effluent each day.

Jones and Washburn have developed a detailed mapping of the chemical and biological components of the outfall plume. Their "yo-tow" instrument package collects data that allow researchers to describe the physical conditions that cause the plume to surface, as well as the relative contributions of effluent nutrients to primary productivity.

Dickey has deployed a multivariable moored system that collects time-series data on the effluent plume and documents events producing resuspension of bottom sediments. Heavy contaminations of DDT exist in sediments near the outfall, so this is valuable information for both local sanitation and public health authorities.

The benthic fluxes of sediments deposited by the White's Point Outfall are being studied by Will Berelson at the Center for Earth Sciences at USC in collaboration with Ken Johnson at Moss Landing Marine Laboratory. These studies are providing important data on nutrient and trace metal fluxes from sediment deposits into the water column. One interesting finding is that benthic fluxes near the outfall are twice as high in summer as in winter. The scientists have also found that trace metal recycling is similar to that found in deep sea sediments and is dependent on oxygen conditions in benthic sediments. This research will ultimately yield vital information about eutrophication of the local marine environment as well as the fate of trace metals injected into these waters by the outfall.

As coastal human populations grow in size, so will the need for more and bigger marine outfalls for disbursing the sewage these people generate. USC Sea Grant marine research is of particular interest to local regulatory agencies, monitoring programs, and public health agencies, but in a larger sense, this work will further our understanding of how large coastal outfalls behave under real-world conditions, how they affect the marine environment, and how they affect human health and safety.



Albacore Marketing Program

Handled properly, seafood is one of our safest and most healthful foods. Sea Grant scientists and Extension staff are working to enhance both the quality and safety of seafood.

Using Edible Films To Keep Frozen Fish Fresher Longer

Sea Grant researchers at the University of California, Davis are working on edible films made from milk protein that can significantly reduce moisture loss and oxidation in frozen fish, maintaining its quality and extending its shelf life.

"Nature protects many foods pretty well itself," food scientist John Krochta explains, "with peels, skins, and the coatings on leaves. We're using materials that are in nature anyway, but we are combining them in new ways."

Although frozen fish keeps much longer than fish at room temperature, it still gradually dries out and undergoes changes in texture, color, and odor that make it less desirable. Most of these changes are the results of moisture loss and the oxidation of oils.

It usually takes several layers of different materials to prevent both moisture loss and oxidation; the problem with multilayer packaging is that it is expensive and hard to recycle. If an edible coating on the food forms an effective moisture or oxygen barrier, the packaging can be simpler. Krochta points out that two-thirds of the volume of domestic garbage is discarded packaging. "We're interested in reducing that waste," he said.

John Krochta, Bruce German, and Michael McCarthy, with their Sea Grant trainee, made edible films from milk casein and other milk and soy proteins. They demonstrated that these protein-based films make excellent oxygen barriers. They found that adding fatty acids and natural waxes, such as carnauba wax, to the films greatly improved the films' moisture-blocking properties as well. The resultant "bilayer laminate" films are flexible and transparent, even invisible, when formed around a product.

"Nature protects many foods pretty well itself with peels, skins, and the coatings on leaves. We're using things that are in nature anyway, but we're combining them in new ways."

One of the most innovative efforts in this project is to attempt to strengthen the moisture barrier by "cross-linking" the protein molecules with various enzymes. The large protein molecules move in space, presenting holes for moisture and oxygen to slip through. The presence of an enzyme can help close the holes. "Cross-linking happens in natural systems all the time," Krochta said. "It's like football players in a defensive line with their arms linked."

It's a challenge to devise ways to observe and verify the extent of cross-linking achieved. "We're bridging or tying together these networks of protein so they're less permeable," Krochta said, "and doing it in a way that's found in nature—but we haven't proved it's going to work yet."

For investigating the best methods of applying and forming edible coatings on frozen fish, the researchers devised a gel to simulate fish flesh. The gel, made from alginate (seaweed extract) and starch, holds its shape when frozen and thawed. Films were applied by spraying and dipping, then dried by ambient air at room temperature and in frozen storage.

The task for the final, third year of the project has been to test the films on frozen fish. Testing requires accurate ways of measuring changes in moisture and oxygen content.

Oxygen content poses the greater challenge. Krochta and his colleagues compared several methods of testing lipid oxidation in samples of Atlantic King salmon and Atlantic Coho salmon, concluding that the peroxide value test, which measures hydroperoxides, the primary initial products of lipid oxidation, was the most accurate.

"If we are successful in developing film coatings that improve both fish quality and shelf life," says McCarthy, "our work could have an important impact on international trade."

Rockfish—A Focus for Research

An astonishing 63 species of rockfishes can be found in California waters, many sporting fanciful names such as bocaccio, chili-pepper, gopher, and treefish.

In 1986, the California Sea Grant College sponsored a major statewide conference on research needs related to these fish, an important group to both the commercial and recreational fishing industries.

Since that meeting, the California Sea Grant College has supported a number of projects on rockfish. Most have been carried out in cooperation or close coordination with the National Marine Fisheries Service (NMFS) and the California Department of Fish and Game (CDFG).

In one of the first studies, Gregor Cailliet of Moss Landing Marine Laboratories (MLML) and Louis Botsford of UC Davis compared traditional methods for determining growth and age of bank rockfish with computer-aided techniques that they developed.

The newer method is an easy-to-use, microcomputer-based system (called "BonyParts") for counting the bands of calcium carbonate that are laid down each year in structures called otoliths—small bones found in the head of fish and thought to play a role in hearing and balance. The work involved contributions from a large number of cooperating organizations. In addition to CDFG, NMFS, and a number of academic scientists, cooperators included the Packard and Myers Foundations and Buehler, Ltd., a company that markets equipment used in thin sectioning.

Cailliet and Kenneth Coale (MLML) and their Sea Grant trainees later used radioactive-isotope dating techniques to verify the accuracy of the new system on bank rockfish and thornyheads.

In another Sea Grant project, Botsford and Frank Henry, Jr. (CDFG) developed computer models to improve the analysis of such data as age and spatial structure of catch comprising several rockfish species, and the impact of fishing mortality on egg production. Their work is presently being used by NMFS fisheries biologists.

With the cooperation of the CDFG, NMFS, Monterey Bay Aquarium, Vancouver Public Aquarium, and a number of academic marine laboratories, Valerie Loeb (MLML), Cailliet, and their Sea Grant trainees established procedures for successfully maintaining gravid rockfish in captivity and rearing the larvae to maturity. They then developed guides for identifying the larvae of these reared species, utilizing such features as size, body shape, and pigmentation patterns. The resulting descriptions will help fisheries researchers to understand the relationships between spawning stock and stock recruitment.

In other Sea Grant research, Timothy Mulligan of Humboldt State University used DNA from cell organelles known as mitochondria to investigate the genetic variability of yellowtail rockfish from northern California to Vancouver Island.

In addition, Joseph Cech and Todd Hopkins of UC Davis, along with Maxwell Eldridge of the NMFS (Tiburon Laboratory), measured the energetic costs associated with larval development in female yellowtail rockfish. As a result of their work, factors like water temperature, food availability, and maternal condition can be better used to predict female fecundity from one year to another.

Finally, Valerie Loeb, Mary Yoklavich, and Gregor Cailliet of MLML are investigating how plumes of cold water from upwelling centers affect the distribution of larval and juvenile rockfish. Their research complements long-term studies by CDFG and NMFS aimed at exploring the possibility that young fish are transported into Monterey Bay from an upwelling center near Davenport, California. If this is shown to be so, the research may provide a basis for establishing marine ecological reserves to provide a continued supply of juvenile rockfish to heavily fished areas.

Extending Prime Time for Fish

Spoiling fish tastes bad . . . and it smells rancid. For obvious reasons, consumers reject it, which leads to substantial waste of an important protein source.

Usually, bacteria are thought to be the culprit when fish spoils, so various methods have been developed by distributors and wholesalers to inhibit or prevent bacterial growth on harvested fresh fish. These technologies include storing the fish in a carbon dioxide atmosphere instead of air, and pasteurizing them with ionizing radiation.

With support from the California Sea Grant College, Norman Haard, David Ogrydziak, and their graduate trainees at UC Davis have been investigating how these methods of controlling bacteria affect the quality and safety of seafood, and whether factors besides bacteria are responsible for the deterioration in seafood quality from Grade A (excellent) to Grade B (mediocre or merely "edible").

At present, one can only hope to maintain Grade A quality in chilled fish for three or four days, whereas the ice time for Grade B is about 15 days.

Using a number of chemical and physical analyses, as well as a panel of expert tasters to evaluate the texture, odor, appearance, and flavor of cooked rockfish, the researchers found that the sensory attributes important to Grade A quality deteriorated at a faster rate in samples treated with either carbon dioxide or ionizing radiation than in a control simply held in air, even though these treatments did reduce the numbers of bacteria present. Further, using a combination of both treatments essentially abolished Grade A market life.

"We were surprised to find that Grade A market life is not related to the numbers of bacteria present at all," Ogrydziak said, "though bacterial load does affect Grade B market life. We discovered that the factors that limit Grade A market life are biochemical reactions that have nothing to do with microbial spoilage, but rather with oxidation of polyunsaturated fats."

"It appears that treating fish to extend its Grade B life actually decreases its Grade A life by promoting undesirable chemical reactions," Ogrydziak explains.

"Providing top quality product is the major challenge facing the U.S. seafood industry today," says Haard. "We must develop better ways of maintaining prime seafood quality, both to meet the demands of American consumers and to open more markets abroad."

J. Bruce German of UC Davis and his Sea Grant trainee have been studying the breakdown of polyunsaturated fatty acids (known to be highly beneficial components of human diets) by natural fish enzymes called lipoxygenases. They have found that these reactions initially provide the compounds that give fish its fresh smell and taste. But later these same reactions may yield unpleasant "fishy" or "cod-liver oil" flavors.

It appears that treating fish to extend its Grade B life actually decreases its Grade A life by promoting undesirable chemical reactions.

In addition to flavor loss, the deterioration of fatty acids causes the loss of therapeutic properties, bleaching of vitamins, and the formation of cholesterol oxides.

"This work will help us to develop methods of processing fish that will both stabilize flavor and protect the polyunsaturated fatty acids of fish from breakdown," German says. "It represents a major advance in understanding how important these enzymes are in generating flavor in fish, and perhaps in all meat. The lipoxygenases are thus candidate enzymes for the industrial production of fresh fish and other flavors."

Providing a Scientific Foundation for Crustacean Culture

Numbered among the more expensive of Americans' favorite seafoods are three crustaceans—marine animals that wear their skeletons on the outside of their bodies. These, of course, are lobsters, crabs, and shrimp. The development or improvement of methods to culture these animals could ultimately be a great boon to U.S. consumers.

Over the past several years, marine shrimp have been one emphasis of Sea Grant-sponsored research at Bodega Marine Laboratory. Shrimp are extensively cultured. The industry, in fact, produces one of the largest cash crops in the world. Because culturists have known very little about the animal's reproductive biology, however, they have been unable to culture it through its full life cycle and have relied on collecting seed stock in the wild.

At Bodega, research has focused on the Pacific rock shrimp (*Sicyonia ingentis*) found off California and the Baja Peninsula. Explains Sea Grant project leader Wallis Clark, "The research done on this species is directly transportable to a number of shrimp species cultured worldwide, and will likely be applicable to very different marine species as well."

As a result of Clark's work, *S. ingentis* has become a model system for studies on the reproduction of shrimp. Basic understanding of the animal's reproductive cycle as well as the mechanisms of fertilization have been achieved. In addition, Clark has developed new techniques that allow him to manipulate many phases of the animal's reproductive cycle.

The California Sea Grant College has also supported collaborative studies between Clark and John Crowe that have resulted in techniques for successfully achieving low-temperature (cryogenic) storage of eggs and sperm.

Using a laser-scanning confocal microscope (which allows operators to optically section and reconstruct an object so it can be viewed in two, and even three, dimensions), Clark and his trainees are also studying early embryological development.

One area they have become particularly interested in is the artificial manipulation of chromosome sets. For example, shrimp eggs undergo complete activation in response to magnesium ions in seawater, not sperm. If unfertilized eggs could be encouraged to undergo normal embryonic division, one could produce "clones" with only maternal chromosomes.

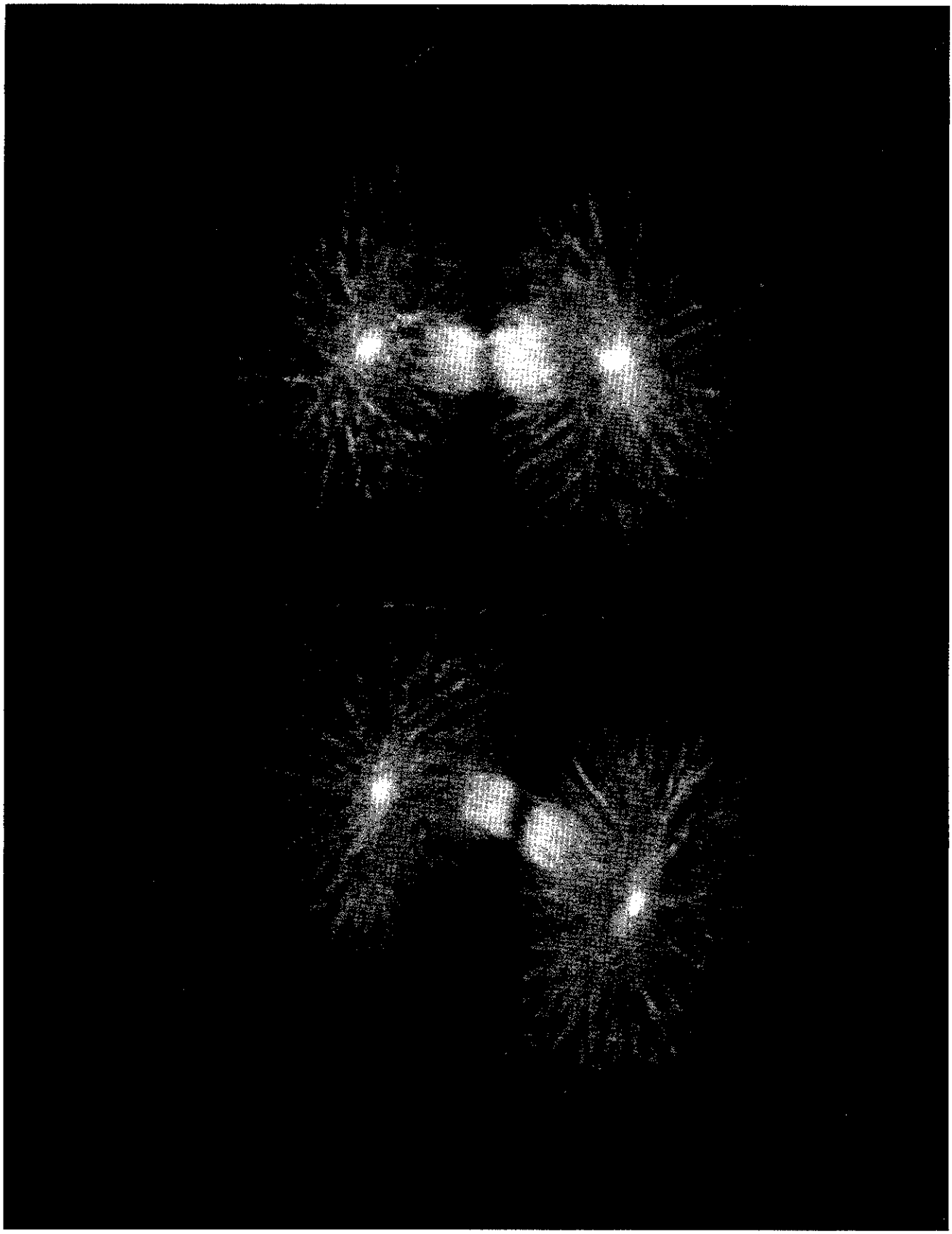
Using technology developed with the Pacific rock shrimp (which allows the rapid and accurate examination of the results of genetic manipulations), Clark has been assisting a California abalone grower, McCormick and Associates, in its development of techniques for the production of triploid abalone. It is hoped that abalone possessing three sets of chromosomes will be sterile and put energy into producing edible meat rather than gonads.

Ernest Chang, also at Bodega Marine Laboratory, is working on another necessary ingredient to successful crustacean culture—a thorough understanding of hormonal control of growth and reproduction. Chang's models have been the American lobster and the Dungeness crab.

In order to increase in size, crustaceans must replace their confining exterior shell, or exoskeleton, with a larger one and subsequently grow to fill it. This periodic shedding of the exoskeleton is accomplished by molting.

In his Sea Grant-supported research, Chang and his Sea Grant trainees have focused on the mechanisms that control the activity of the molting gland. They have also identified and chemically characterized a hormone produced by a small organ in the eyestalk of the lobster that inhibits molting.

"The most promising prospect for the crustacean culture industry in the United States may well be the development of intensive, high-technology culture systems," Chang says. "But such development must rely on a comprehensive understanding of the basic biology of growth and reproduction."



Mitosis at the two-cell stage in the Pacific rock shrimp as revealed by the laser-scanning confocal microscope. Chromosome manipulation may lead to better quality, more reliable seafood products.

Accelerating the Growth of Shellfish in Culture

Abalone production is now commercially successful in California, and the industry is growing rapidly. The first two private companies in the world to achieve profitable abalone production are located in California, and abalone growers may now be found in Crescent City, Bodega Bay, Santa Cruz, Cayucos, Goleta, Oxnard, and Port Hueneme.

The success of California's abalone aquaculture industry has been the result, in part, of cooperative research by the industry and by Daniel Morse of UC Santa Barbara, his colleagues, and trainees.

At the start of their research, sponsored by California Sea Grant College, the Santa Barbara team identified three major bottlenecks that had to be overcome to make abalone production commercially efficient and highly successful. These were control of spawning, control of larval metamorphosis, and acceleration of growth.

For each of these, Morse and his students first identified the natural environmental triggers that control these processes. In the case of spawning, they found that the natural trigger is a hormone called prostaglandin. They then developed a simple and inexpensive application of this finding, in which hydrogen peroxide is used to stimulate the animal's internal synthesis of prostaglandin. This method is very convenient and reliable, and is now widely used by industry to induce spawning.

In subsequent work, the group found that settlement and metamorphosis of abalone larvae to their juvenile form are naturally triggered at the surface of specific red algae. They also discovered that this process can be conveniently induced in hatcheries by using an inexpensive chemical, GABA. This method also is now used by a growing number of commercial abalone producers in California.

And finally, the group found that the growth of abalone—which is often slow—can be significantly accelerated by adding to the water very low concentrations of hormones that the animal produces normally. These are growth hormone and an insulin-like hormone known as "MIP."

Their present work aims to develop a simple method for stimulating the abalone itself to produce these growth-accelerating hormones.

Thus far, they have determined that MIP is produced in abalone brain cells, and they have cloned and sequenced the gene responsible for this hormone. Now they will be able to identify the nutritional and environmental factors that stimulate the animal to produce the hormone.

"This research and its commercial applications are designed to develop cost-effective means to safely accelerate the growth of abalone and other shellfish in culture, without introducing hormones or manipulating the genetics of the stock," says Morse.

"This research and its commercial applications are designed to develop cost-effective means to safely accelerate the growth of abalone and other shellfish in culture, without either introducing hormones or manipulating the genetics of the stock."

California's aquaculture industry has been very active in assisting this effort. Cooperating organizations such as The Abalone Farm, Inc., Ab Lab, Inc., The Cultured Abalone, Inc., and the Santa Barbara Abalone Association have provided technical assistance, abalone, and stocks of feed algae. Morse also has active collaborators in the United States, Japan, Taiwan, and the Netherlands.

Providing Better Quality Urchin Roe

"It tastes sweet and salty, and it melts in your mouth." That's how one sea urchin buyer described sea urchin roe, a bright orange or yellow mass eaten raw on flavored rice in Japan and Korea. California exports sea urchin roe (there's virtually no domestic market for the product); the 1991 harvest of 41.5 million pounds was sold for roughly $23 million.

Paul Singh, a professor of food engineering at UC Davis, has devised a mechanical system to help sea urchin processors improve their product quality. Today, processing is done almost entirely by hand, and processors report approximately 20 percent loss of roe from damage in handling.

At present, buyers truck crates of the spiny creatures directly from the dock to the processors. Workers rake the urchins out onto tables, and crack them by hand. They use long-handled spoons to remove the roe (actually the animal's gonads), then wash and carefully place the roe on small trays.

The product should reach its market overseas in no more than three days, and in virtually the same condition as it's found in the shell. Any damage lowers the price or makes the roe unsellable. Freezing or other forms of preservation alter its appearance and flavor and are not acceptable in the Asian markets.

After visiting several California sea urchin processing plants, Singh concluded that a mechanized processing system would aid the industry by lowering the cost of processing and helping to maintain a high-quality product.

With support from the California Sea Grant College, Singh and his associates have devised a mechanical system for removing the roe that can potentially reduce damage by 50 percent or more. The researchers also found a way to crack the shell without damaging the delicate product inside.

A professor of food engineering at UC Davis has devised a mechanical system to help sea urchin processors improve their product quality.

A prototype system now ready for testing on a larger scale combines manual cleaning and breaking of the shells with an ingenious mechanical device to remove the roe. First, workers remove the spines from the tops of the shells, exposing a pattern that indicates which lobes contain the gonads. They cut each shell between the lobes, assuring that the gonads will not be damaged, and place each half in a gripper on the end of a rotating lever arm.

The lever arms hold the open half-shell upside down; each arm in turn drops against a hard rubber block, dislodging the roe by impact. The product drops onto individual pans, or sieve trays, moving along underneath the lever arms. Each arm then rotates 90 degrees, exposing the shell for inspection. Less than 10 percent of the gonads break when this method is used.

"It is also more hygienic," Singh points out, "to remove the roe mechanically, especially since the roe is eaten raw." In addition, a mechanized system makes it possible to control the amount of water used to wash each piece.

In a "supply side" approach, two students working under the direction of Wallis H. Clark and Douglas Conklin at the Bodega Marine Laboratory (UC Davis), experimented with three variables in rearing larval urchins to metamorphosis. These were diet, temperature, and density.

If young urchins could be cultured, it might one day be possible to reseed depleted fishing grounds or to culture the delicacy commercially.

The Bodega researchers were very successful in achieving fast larval growth in high densities and with large percentages of larvae successfully completing metamorphosis.

Sea Grant's marine extension advisors are now educating industry about the new techniques.

SIO photo

On collecting expeditions to the South Pacific and the Caribbean, Sea Grant researchers, such as William Fenical on the right, have found marine organisms that contain compounds which may one day be used to treat arthritis and other inflammatory diseases.

Finding Remedies from the Sea

In the beginning—before asthma, or arthritis, or psoriasis, or any of the ailments that fall into the category of inflammatory diseases—there is arachidonic acid, a compound found in cell membranes in every organ of the body.

When the cell is irritated or injured, an enzyme (PLA_2) brings about the release of arachidonic acid from the cell membrane, initiating two major chain reactions that eventually lead to pain and inflammation.

"Inflammation is a general process," says Robert Jacobs, a professor of pharmacology at UC Santa Barbara. "When it happens in the kidney, we call it nephritis; when it happens in the joints, rheumatoid arthritis; in the heart, carditis; and so on. But it's all really the same series of reactions."

Jacobs and his colleagues, William Fenical and D. John Faulkner of UC San Diego's Scripps Institution of Oceanography, have been sorting through exotic marine organisms in search of drugs that might one day hold out hope against inflammatory diseases and other ailments. Their Marine Chemistry and Pharmacology Program has been supported by California Sea Grant since 1977.

There's nothing new in using natural products as drugs or as the chemical pattern from which to model synthetic versions. Penicillin, aspirin, and morphine are just a few of the medications originally found in nature. But terrestrial sources of drugs have been pretty well explored.

On the other hand, although nearly 80 percent of all life on Earth inhabits the oceans, marine plants, animals, and bacteria are only now beginning to be considered for their pharmacological potential.

Scientists involved in this new venture are impressed not only with the variety of marine organisms, but with their chemical uniqueness. "In marine organisms we find compounds arranged in completely different ways from those found in land plants and animals," says Fenical, "and these different patterns of construction can lead to totally different mechanisms of action within the human body."

For example, aspirin works after PLA_2 has released arachidonic acid from injured tissue by blocking one of the two main pathways that lead to inflammation. But aspirin (and ibuprofen as well) leaves the other inflammation pathway unaffected.

The drug industry has known for 20 years that if it could find an inhibitor of PLA_2, it could stop *both* pathways in their tracks. So far, however, it has been unsuccessful in finding such a compound in land organisms.

On the other hand, PLA_2 inhibitors have been discovered by Sea Grant's researchers in a variety of marine organisms. For example, one class of compounds, called pseudopterosins, was found in a soft coral sea whip; another, manoalide, in a sponge.

Today, a number of pharmaceutical companies are working with this research team to develop drugs from the sea. These include Merck, Sharpe and Dohme Company, the Sterling Drug Company, Ligand Pharmaceuticals, Wyeth Ayerst, Allergan and Osteo-Arthritis Sciences, Inc. Says Faulkner, "the large number of marine natural products that show anti-inflammatory activity suggests that new PLA_2 inhibitors will be discovered in the marine environment for the foreseeable future." Adds Jacobs, "our program has become the primary resource for compounds that are being developed for the treatment of inflammatory diseases."

"The promise of the work we are doing to alleviate human suffering is high," says Fenical. "This research can also help to ensure that both our nation and our state retain leadership positions in biotechnology and, more particularly, marine biotechnology."

California Sea Grant is also supporting a drug discovery program targeting infectious diseases, headed by Phillip Crews of UC Santa Cruz. Another project, led by Alison Butler of UC Santa Barbara, is seeking new biochemical routes for the production of drugs and specialty chemicals.

Assessing Earthquake Risk to Drilling Platforms

To life's list of inevitabilities, like death and taxes, we in California must also add earthquakes.

In 1989 alone, the Golden State recorded more than 15,000 earthquakes. Of these, the most infamous was the Loma Prieta earthquake, which claimed 62 lives and resulted in nearly $7 billion in property damage.

The Loma Prieta event is just one in a series of more than 20 major earthquakes to hit the coastal zone of California since 1800. Appreciation of the frequency of these events, coupled with understanding of the fragility of coastal environments and the concentration of human populations along California's coast, suggests the urgency of preparing for the inevitable.

One of the risks in Central California is damage to or collapse of oil and gas drilling platforms. At the present time, there are about 35 major platforms in ocean waters off Santa Barbara and Ventura counties, some of which are well over 30 years old.

In the present economic and political climate, the offshore oil and gas industry is under heavy pressure both to control rising operating costs and to raise the productivity of existing facilities. Thus, there are critical questions on how best to extend the lives of these structures on the one hand, and how best to identify those structures that should be taken out of service on the other.

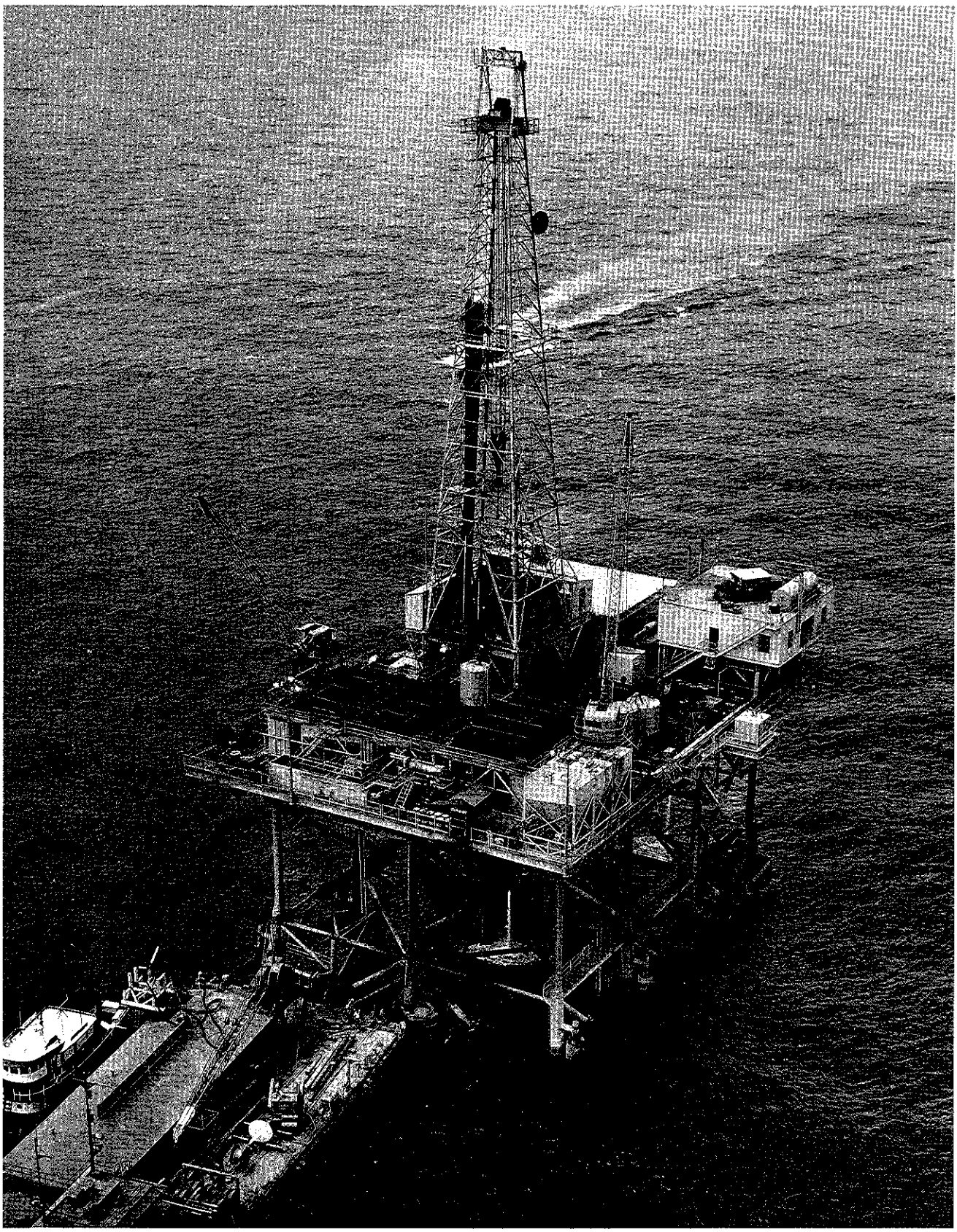
With support from the California Sea Grant College, C. William Ibbs and Robert Bea of UC Berkeley and their trainee are using lessons drawn from the Loma Prieta earthquake to develop computer-based software and procedures for requalifying platforms for seismic hazards. Their work is intended to permit rapid evaluation of how a platform might behave under a wide variety of potential earthquakes and how remedial work on the structures might improve seismic performance.

A number of lessons were drawn from the Loma Prieta earthquake about factors affecting platform performance during a quake. These include recognition of the effects of different ground motions. Vertical motions, for example, can seriously damage heavily loaded cantilever or long-span platform decks. The effects of different kinds of soils in modifying or even amplifying earth motions must also be considered. Liquefaction, for example, can cause problems with pipelines and other utilities. Failure of other components, such as piping, risers, utilities, and even vessels, can result in fires, explosions, and pollution and in some cases can result in failure of the platform. And, of course, if the platform is technically obsolete, poorly constructed, or seriously deteriorated, then it is not likely to perform acceptably in an intense earthquake.

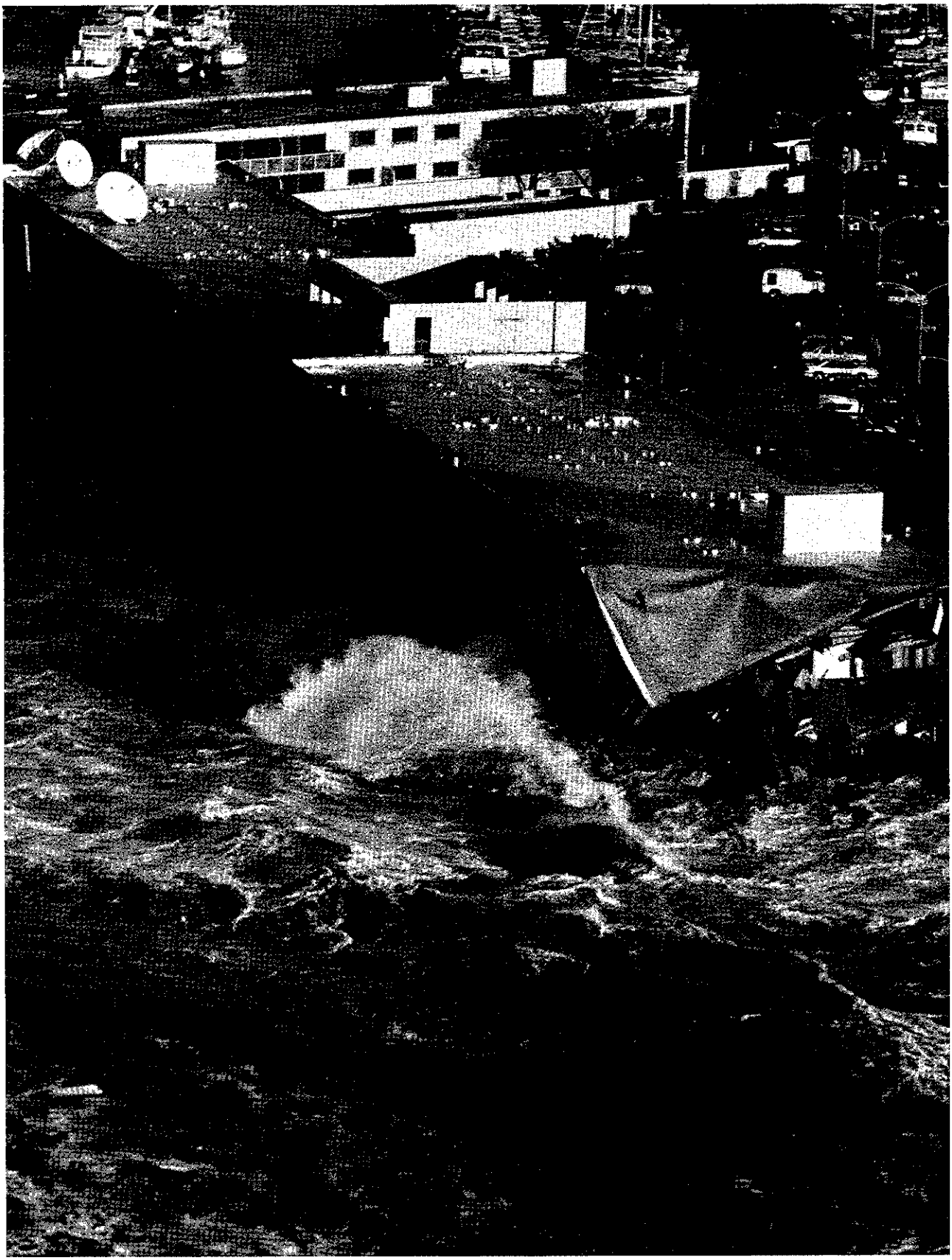
A number of lessons were drawn from the Loma Prieta earthquake about factors affecting platform performance during a quake.

The assessment scheme being constructed by Ibbs and Bea integrates all of these considerations in order to evaluate the likely demands on a particular platform, its strength, the consequences of its failure, and the program of inspection, maintenance, and repair that should be implemented. The result is a decision on the acceptability of the platform for continued service and on possible techniques for upgrading the structure.

The present project has matching funds from the California State Lands Commission and the Minerals Management Service of the U.S. Department of Commerce and includes on its advisory committee representatives from Exxon, Amoco, Texaco, Unocal, and Mobil Oil Companies.



An assessment procedure being developed with support from California Sea Grant will describe a program of inspection, maintenance, and repair to assure that offshore platforms can withstand seismic hazards.



Los Angeles Times

Redondo Beach sustained some $16 million in damage to coastal structures during the infamous storm of '88.

Predicting Wave Conditions in Southern California

In January 1988, an unexpected storm born in the eastern North Pacific struck California. The storm was short, but fierce, generating the largest waves ever recorded in the Southern California Bight.

Damage was particularly heavy in the southern part of the state. In the Redondo Beach–King Harbor area, where a submarine canyon concentrated wave energy, waves estimated at more than 20 feet crashed through the breakwater to destroy an estimated $16 million worth of coastal structures.

Like the storms of 1978 and 1982-83, this one forced coastal planners back to the drawing board to revise their estimates of extreme wave conditions along the California coast.

In order to estimate wave conditions at particular locations, planners turn to computer models. Unfortunately, the Southern California Bight has proven to be a particularly challenging region for modelling waves. Difficulties arise not only because the Channel Islands partially shelter the coast from storm waves arriving from the North and South Pacific, but also because the islands, submarine canyons, and shallow banks of the Bight create very complex wave patterns.

Both the Coastal Data Information Program and the National Oceanic and Atmospheric Administration have collected wave data at a number of locations, usually for specific needs, but the complexity of conditions within the Bight has made it difficult to relate such data to other locations where there are no wave instruments.

Like the storms of 1978 and 1982-83, this one forced coastal planners back to the drawing board to revise their estimates of extreme wave conditions along the California coast.

With support from the California Sea Grant College and the California Department of Boating and Waterways, Robert Guza of UC San Diego's Scripps Institution of Oceanography and his graduate trainees have adapted two computer models to allow scientists to use an existing wave-monitoring network to estimate wave conditions at sites without instruments.

"Basically" says Guza, "our idea was to use simultaneous measurements of wave direction and energy from a number of existing locations throughout the Bight to *infer* the direction of waves out in the deep ocean beyond the Channel Islands. Using these estimates of which direction storm waves were coming from, our models predicted expected wave conditions at locations without wave gauges."

To test their computer models, Guza and his trainees constructed and deployed self-contained wave gauges in two 3-month tests. The first deployment was designed to monitor Southern Hemisphere waves; the second, to monitor winter waves from the Northern Hemisphere.

Initial analysis of the winter data indicates that the models worked well. It further suggests that a directional buoy in the deep ocean could provide useful predictions of wave energy within the Bight.

"These preliminary findings have led to specific recommendations for the expansion of existing wave-monitoring networks as well as for future field verification experiments," Guza says.

Preliminary results also show, however, that more sophisticated prediction schemes are necessary in some of the more geographically complicated regions in the Bight—for example, near coastal submarine canyons and at the east end of the Santa Barbara Channel.

One of the computer models developed in this project is already being used by the Los Angeles office of the Army Corps of Engineers, and the Corps is using research results to plan future expansion of the Coastal Data Information Program. Additional analysis of the field data is continuing with support from the California Department of Boating and Waterways.

Sea Grant Traineeships—A Commitment to the Future

"The experience I had as a trainee was incredibly value for me. I wouldn't be where I am today without it."

This is one of the accolades received during a recent survey of former graduate trainees of the California Sea Grant College. Over the years, Sea Grant support of master's and doctoral students has provided a major source of talent in a diversity of marine-related fields such as oceanography, ecology, engineering, geology, law, and food science.

The California Sea Grant College is committed to its legislative mandate: to provide a program of training and research in the field of marine science, engineering, and related disciplines. In the last 20 years, over 750 graduate students have benefited from such traineeships.

Where are these trainees now? A recent survey produced 136 responses. Of these, the largest group (45%) currently holds faculty or research positions at colleges, universities, and other academic institutions, followed by 26% in federal, state, or local government programs; 18% in private industry; 7% pursuing postdoctoral degrees; and 4% in the legal and secondary teaching professions.

Former trainees include the research director at the Monterey Bay Aquarium, a senior executive at Hubbs-Sea World Research Institute, and a project leader with the International Institute of Tropical Agriculture in Nigeria. Others hold administrative posts with the National Institutes of Health, the National Science Foundation, and the Environmental Protection Agency. They are to be found in the Peace Corps, as scientists and engineers in private industry, and as naval architects.

Some responded to the survey with comments on their traineeship and the impact it had on their careers. An associate professor at Washington State University wrote, "I now have a career as an oceanographer studying the nearshore region (waves, sand, currents). This was precisely the training I received as a Sea Grant trainee. This is a great program, and certainly benefited me tremendously." A professor of biological sciences at Texas Tech University stated, "The importance of my Sea Grant training is underscored by the fact that some of the techniques I developed as a trainee are now in widespread use in many laboratories across the U.S." And the president of a private corporation commented, "Research on Mexican and Native Alaskan fishermen funded under Sea Grant started it all—my company has flourished as one of the only 'anthropology' research firms in the world."

USC Sea Grant Trainee Program

Trainees from the University of Southern California Sea Grant Program presented their research at the 1990 and 1991 annual meetings of the Southern California Academy of Sciences. The Academy's close ties to the USC Sea Grant Program enrich the trainee experience by providing a venue for graduate students to communicate with scientists and to present the results of their work.

Coming from the fields of biology, geology, urban planning, engineering, economics, and business, former USC trainees are well prepared to assume leadership roles in research and development in marine-related fields.

Former trainees include the current deputy director for exhibits and education at the California Museum of Science and Industry, and an international relations consultant to the United Nations International Development Authority, the Institute for Defense Analysis, and the World Bank.

In the past five years, USC trainees have gone on to research positions at the Smithsonian Institution in Washington, D.C.; the Jet Propulsion Laboratory in Pasadena, California; the University of Connecticut Health Sciences Center; the University of Florida; the Atlas Testing Authority (an aerospace engineering firm in Los Angeles); the University of California; and government agencies such as the California Department of Fish and Game.

Sea Grant Support of Educational Opportunities

In addition to supporting graduate education in the marine sciences and technology through its trainee program, Sea Grant in California conducts a variety of other educational programs.

Each year, Sea Grant programs around the nation nominate graduate students for a year-long fellowship in the nation's capitol. Called the John A. Knauss National Sea Grant Fellowship, this program matches graduate students who have demonstrated interest both in ocean policy and marine science with government "hosts" in Washington, D.C. The California Sea Grant College has been honored to have five nominees selected as fellows between 1987 and 1992. They are: Allan Dietz , Senate Environment and Public Works Committee; Aaron King, House Committee on Science and Technology; Anne Petrenko, Office of Global Programs, NOAA; Alessandra Conversi, Ocean Science Research Section, National Science Foundation; and David Wilmot, Ocean Studies Board, National Research Council.

In 1987, the California Sea Grant College initiated a State Fellowship Program modeled on the national program. Fellows through 1992 have been: Craig Denisoff, Joint Committee on Fisheries and Aquaculture; Robert Wilder, Joint Committee on Fisheries and Aquaculture; Aaron King, Office of Assemblyman Dan Hauser; Julie Reynolds, Channel Islands National Marine Sanctuary; Bruce Wulkan, Secretary of Environmental Affairs; Rob Pollard, Senate Natural Resources and Wildlife Committee and State Lands Commission; Linda Rao, Joint Committee on Fisheries and Aquaculture; Susan Reidy, Office of Assemblyman Dan Hauser; Mark Evans, Pacific Fisheries Legislative Task Force; and Melody Paige Tate, Senate Committee on Natural Resources and Wildlife.

An experimental program to support independent thesis research in the marine sciences was initiated in 1990. The purposes of the program were to provide support for meritorious independent graduate student research and to recognize the independent contributions of students. In 1990, six students received the awards: Kevin Lafferty, UC Santa Barbara; Erik V. Thuesen, UC Santa Barbara; Blaise J. Eitner, UC Los Angeles; Peggy Fong, San Diego State University; Melissa Gibbs, San Jose State University; and Charles Lester, UC Berkeley. Two of these students, Kevin Lafferty and Eric V. Thuesen, were awarded fellowships in 1991 as well. The other 1991 recipients were: Stacy Baczkowski, San Diego State University; Sherry L. Fitzsimmons, UC Davis; James Kanihan, San Jose State University; Heidi M. Nepf, Stanford University; and Steven A. Osborn, San Jose State University. Fellows in 1992 were Michael Banks, UC Davis; Sherry Fitzsimmons, UC Davis; Hae Jin Jeong, UC San Diego; and Theresa Stevens, UC Santa Barbara.

The California Sea Grant College also awards a four-year college scholarship each year to a high school senior who shows particular aptitude in marine science. Winners of the John D. Isaacs Memorial Scholarship from 1988 to 1992 have been: Russell Scott Shapiro, Humboldt State University; Michelle Brand, UC Santa Cruz; Elizabeth Springer, Stanford University; Rose Marie Gregory, UC Berkeley; and Kenia Whitehead, UC San Diego.

USC Marine Education

Over the years USC Sea Grant has developed an extensive set of bilingual marine education materials in English and Spanish for use by California teachers in K–6 classrooms. Marine Advisory Service staff regularly support teacher-training seminars throughout Southern California to emphasize marine resource issues and to deliver these materials.

USC Sea Grant has assisted in developing an outreach program for elementary schools on resource recycling along the coastline. It has participated in pilot delivery of that program in coordination with Los Angeles schools and is seeking funding to disseminate the program throughout Southern California.

California Sea Grant Extension Program

Part of Sea Grant's mission is to move the results of the research it sponsors out of academia and into the hands of people who use or manage California's coastal and marine resources.

Sea Grant's primary arm for achieving such information and technology transfer is its Sea Grant Extension Program, which uses both field advisors and technical specialists to provide information and advice to a wide variety of groups. Conversely, the program seeks to make university scientists aware of the information needs of these groups.

Program Coordinator & Marine Fisheries Specialist
Christopher Dewees
University of California, Davis

Marine Fisheries Specialist Christopher Dewees has been active in promoting consideration of new fishery management alternatives. During a 1987 sabbatical leave, he conducted an in-depth socio-economic study of the early effects of New Zealand's revolutionary individual transferable quota (ITQ) system on fishermen and fishing companies. The results of his studies were published in two journal articles and several extension publications. He continues to advise fishermen, management agencies, researchers, and environmental groups about the benefits of and problems with ITQ implementation.

Dewees has also continued work on a Sea Grant extension project to improve fuel efficiency in California's fishing fleet. The project has used education, at-sea demonstrations, research, and a state-run low-interest loan program to encourage vessel owners to retrofit their vessels. The program has proved so effective—advisors were able to document a 17-percent reduction in fuel consumption among participating vessels—that in 1992 the California Legislature approved an expanded fisheries energy loan program. This program is presently being implemented.

In 1992, Dewees was co-organizer (with Wallis Clark) of a major international conference on sea urchins and other kelp bed resources.

In addition, with a grant from the National Marine Fisheries Service, he revised and updated *California's Living Marine Resources and Their Utilization*, a classic work first published in 1971 by the Department of Fish and Game at the request of the California Legislature.

Food Science Technology Specialist
Robert Price
University of California, Davis

Specialist Robert Price has been actively working with the seafood industry to meet consumer demands for improved seafood safety and quality.

Price recently helped to develop an educational training program to assist industry in implementing a new safety system for food processing called the "Hazard Analysis and Critical Control Point" system (HACCP). In the coming year, this training program will be conducted in California and several other locations around the nation.

With Program Representative Pamela Tom, he developed a two-day workshop on "Seafood Quality Determination and Species Identification," and he has participated in numerous educational programs for seafood retailers, processors, and agency inspectors.

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In addition, Price wrote an introduction to HACCP for delicatessen managers, *Ensuring Food Safety—the HACCP Way*, recently published by Sea Grant. This project was also supported by the Extension Service of the U.S. Department of Agriculture and had a large advisory board that included representives of industry leaders such as Safeway, Vons, and Bel Air Markets.

At present, he is working with the California Seafood Council to develop a seafood quality code for California fish and shellfish. He is also attempting to improve consumer confidence in seafood by educating the news media to the fact that seafood is among our safest foods.

Del Norte and Curry Counties
James B. Waldvogel, Area Advisor

At the request of port managers within the Klamath Management Zone (KMZ) who were concerned about the effects of closures and restrictions instituted by the Pacific Fishery Management Council, Advisor Jim Waldvogel conducted a survey of ocean salmon sport fishermen throughout the five KMZ ports during the summer of 1991. His questionnaire requested detailed information relating to demographics and port usage; it also asked anglers' opinions on a number of fisheries issues. In the survey, many fishermen reported that they were considering moving to new ocean ports because of the KMZ restrictions. In fact, a major shift in fishing effort did occur in 1992, with serious economic consequences to KMZ ports and businesses. Waldvogel's report is being used by all five ports in their efforts to better address anglers' perceptions and needs, and thus improve the region's economic climate.

Waldvogel has also been involved in a long-term study of Chinook salmon escapement on the Smith River, the only major river system in California that is still undammed. He is a technical advisor to the Klamath River Task Force, the Klamath Management Council, and was recently appointed to the "Native American Committee" of the American Fisheries Society, which considers important national and regional issues that may affect Native American communities or fisheries.

San Luis Obispo, Santa Barbara, & Ventura Counties
Deborah McArdle, Area Advisor

John Richards, who was area marine advisor for this region until fall 1992, served for the past four years on the Morro Bay Task Force, a group seeking National Estuarine Program status for Morro Bay. He helped to plan a regional symposium on the value of Morro Bay and co-edited the proceedings to which he contributed papers on the fishing and shellfish aquaculture industries.

Richards also conducted a major West Coast workshop in 1991 on the black-abalone withering syndrome, which has devastated abalone populations in south-central and southern California. The proceedings of that meeting have been used by researchers in developing studies to determine the cause of the syndrome. In addition, he completed a two-year cooperative project with San Diego State University to determine recruitment periods of juvenile sea urchins.

Richards worked with Specialist Chris Dewees in revising *California's Living Marine Resources and Their Utilization*, a statewide reference work. He recently moved

to Washington State to manage a commercial mariculture operation.

Newly named to this position is Deborah McArdle, who has previously worked for the Indian River Lagoon National Estuary Program, the Caribbean Marine Research Center, and the New Jersey Bureau of Marine Fisheries. McArdle recently completed her Master's thesis at the Florida Institute of Technology on sea urchin ecology.

Humboldt & Mendocino Counties
Susan McBride, Area Advisor

Susan McBride, previously hatchery manager for a commercial abalone farm in California, joined Sea Grant in 1992 as the marine advisor for Humboldt and Mendocino Counties. Since aquaculture is one of her areas of expertise, McBride participated in an "economic summit" at Humboldt State University last fall at which she addressed the potential for aquaculture in the north coast region.

She also recently toured the Fort Bragg area, examining aquaculture sites suggested by the local Chamber of Commerce. In addition, she has consulted with the Eureka Main Street Program and Chamber of Commerce on a possible role for Sea Grant in suggesting possible waterfront development in Humboldt Bay.

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McBride co-sponsored a weather workshop with two meteorologists from the National Weather Service in Eureka. The workshop covered existing and future weather services available to commercial and recreational mariners.

Her immediate predecessor was acting advisor Fred Jurick. Jurick had worked closely with United Anglers, a sports fishing organization, on a project to construct an artificial reef off the coast, whose purpose is to reduce fishing pressure on the few accessible natural reef areas.

Marin & Sonoma Counties
Area Advisor To Be Named

Bruce Wyatt, who recently retired as a Sea Grant advisor, worked actively with the sea urchin industry to bring its concerns about resource depletion to the attention of both management agencies and academic researchers and to help design research projects that might contribute to the enhancement of this valuable resource.

He also worked closely with seafood processors to investigate the use of seafood waste as fertilizers and as additives to livestock feed.

Public education was another area in which Wyatt was actively involved. Over the past five years, he trained 150 elementary school teachers and their students to hatch salmon eggs in the classroom. After several weeks, the students planted the young fish in local streams. The project was embraced by environmental groups, which provided funding for aquariums, as well as by students and teachers.

Monterey & Santa Cruz Counties
Rick Starr, Area Advisor

Rick Starr is a former program leader of marine research surveys with the Oregon Department of Fish and Wildlife. His interests include shoreline and marine resource planning, marine fisheries, and the use of geographic information systems (GIS) to track the distribution of marine resources and their changes through time. He has studied a variety of marine species including scallops, squid, rockfish, and grey whales.

Edward Melvin, his predecessor, was active in marine fisheries development. In a special project funded by

Starr's interests include shoreline and marine resource planning, marine fisheries, and the use of geographic information systems (GIS) to track the distribution of marine resources and their changes through time.

the National Marine Fisheries Service, Melvin and Steven Osborn of Moss Landing Marine Laboratories addressed a number of problems confronting the new West Coast fishery for Pacific hagfish. Their aim was to determine optimal techniques for capturing and handling the animals, as well as to control problems affecting the quality of hagfish skins. Melvin is presently an extension advisor for the Washington Sea Grant College Program.

San Francisco Bay Counties
Area Advisor To Be Named

Constance Ryan, Sea Grant Area Advisor from 1983 to 1992, was a leader in designing educational materials to meet the needs of the Vietnamese-speaking fishing community in California.

She also worked cooperatively with the National Marine Fisheries Service to investigate the basic life history and population characteristics of Pacific hagfish, information necessary to management agencies working to protect the resource.

In addition, Ryan worked actively with a number of school districts in the Bay area to promote a classroom project on steelhead reproduction and development.

She recently accepted a position as unit manager with the California Department of Fish and Game.

San Diego, Los Angeles, and Orange Counties
Leigh Taylor Johnson, Area Advisor

Marine Advisor Leigh Johnson and Cooperative Extension Environmental Issues Advisor Valerie Mellano were funded by the USDA Extension Service to develop a national model for empowering agriculture, environmental groups, and government agencies to work cooperatively in reducing agricultural impacts on coastal water quality. The project used San Diego County as a model.

Johnson, Mellano, and their assistants, conducted research on the regulatory framework addressing agriculture and nonpoint source pollution, as well as the opinions of affected groups. These groups, called "stakeholders," included agricultural producers, environmental groups, and government agencies. Stakeholders later participated in two forums where they developed priorities for action.

Following a talk given by Johnson and Mellano, Farm Bureau members in three neighboring counties began working with local regulatory agencies to reduce nonpoint source pollution. The two advisors also made presentations to regional and national Cooperative Extension conferences. Their project results were disseminated nationally in a case study.

Johnson and Mellano plan to develop educational material on coastal ecosystems, the impact of nonpoint source pollution, and "best management practices" for reducing pollution.

In addition, Johnson and Mellano have been funded by the EPA Near-Coastal Waters Program for 1992-94 to implement the recommendations of the forums. They plan to develop educational material on coastal ecosystems, the impact of nonpoint source pollution, and "best management practices" for reducing pollution.

Johnson also chaired the 1990 San Diego Bay symposium and later served as chief editor of the *San Diego Bay Report*, a summary of the symposium recommendations issued by the San Diego Interagency Water Quality Panel.

USC Marine Advisory Services Susan Yoder University of Southern California

The size and diversity of the Los Angeles region strongly influence the assistance delivered by the USC Marine Advisory Service (MAS).

Susan Yoder, Coastal Resources Specialist, is technical advisor to the Santa Monica Bay Restoration Project (SMBRP), a part of the National Estuaries Program that is identifying major environmental problems associated with the Bay and developing a management plan to address those problems. She also works on the SMBRP Wetlands Committee.

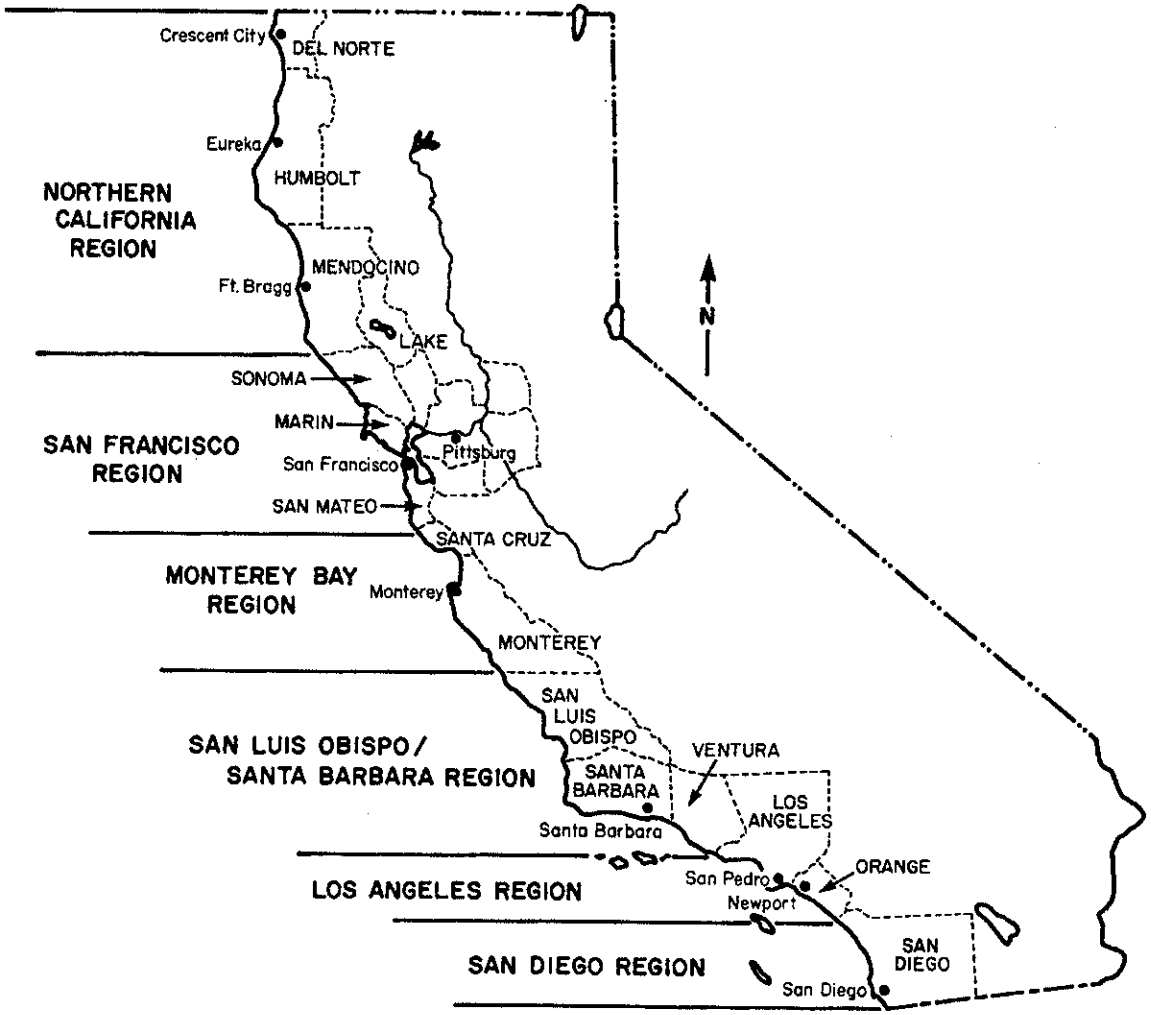
Since 1990, Yoder has organized six symposia and workshops on the marine environment, under the auspices of the Southern California Academy of Sciences, the American Society of Civil Engineers, and other groups.

Under the leadership of James Fawcett, who recently left the program, the MAS was also instrumental in explaining the 2020 Plan, an immense port development project in Los Angeles/Long Beach, to business and public groups throughout Southern California. It also provided direct assistance to the port in organizing a workshop on conflict resolution to teach principled negotiation to staff from departments as diverse as engineering and accounting.

In cooperation with the Federal Maritime Commission, USC Sea Grant sponsored a conference in 1987 on the Shipping Act of 1986, which brought together 400 managers of carriers, shippers and shipping managers. A second conference, the Second International Coastal Ocean Space Utilization symposium, brought together 150 attendees from 14 countries. That meeting was sponsored by the National Oceanic and Atmospheric Administration and the National Science Foundation to enhance international understanding of coastal development practices.

Yoder is technical advisor to the Santa Monica Bay Restoration Project, a part of the National Estuaries Program that is identifying major environmental problems associated with the Bay and developing a management plan to address those problems.

California Sea Grant Benefit Regions



Directory of Projects by Institution*

NORTHERN CALIFORNIA REGION

Humboldt State University

R/CZ-81	Stochastic Analysis of Estuarine Hydraulics (Willis, 1987-89)
R/CZ-84	Management Models of Wetland Wastewater Treatment Systems (Finney, 1988-90)
R/CZ-86	Relative Holocene Sea Level Fluctuations and Vertical Crustal Movement (Carver, 1988-89)
R/CZ-88	Paleoseismicity and Relative Sea Level Fluctuations, Humboldt Bay, California (Carver, 1989-90)
R/F-131	Temporal and Spatial Variation in Species Composition of the Deep Water Eureka Bottom Trawl Fisheries, with Emphasis on Sablefish (Hankin, 1989-90)
R/NP-1-18H	Temporal and Spatial Variation in the Species Composition of Deep Water Eureka Trawl Fisheries, with Emphasis on Sablefish (Hankin, 1988-89)
R/NP-1-20A	Population Studies on Yellowtail Rockfish: Management for the U.S. and Canada (Mulligan, 1990-91)

SAN FRANCISCO REGION

San Francisco State University/Romberg Tiburon Center

R/CZ-83	Seagrass Revegetation: Physiological and Environmental Criteria for Successful Transplanting (Josselyn/Alberte, 1987-89)
R/NP-1-17L	Selection of Sites for Bivalve Bioindicator Monitoring Programs (Segar, 1988-89)

University of California, San Francisco

R/NP-1-18E	Development of a Fish Assay for Detection of Worm Infestations (Sakanari, 1988-89)

University of California, Berkeley

R/CZ-89	Experimental Studies on the Response of Cohesive Sediments to Wave Motion (Hunt/Foda, 1989-91)
R/CZ-100	Tidal Processes, Morphology and Accretion, San Francisco Estuary Saltmarshes (Stoddart/Leopold, 1990-91)
R/F-117	Endocrinology and Physiology of Salmonid Development and Seawater Adaptation (Bern, et al., 1987-90)
R/F-145	Control of Growth and Survival in the Striped Bass (Bern, 1991-92)
R/MP-43	Agricultural Pest Control Agents from Marine Organisms (Kubo, 1987-89)
R/OE-2	Stability of Submarine Pipelines Against Breakout Failure (Foda, 1987-88)
R/OE-5	System Reliability of Offshore Structures (Mansour, 1987-89)
R/OE-11	Methodology for Assessment by Regulatory Bodies of the Safety of Existing Steel Offshore Platforms (Gerwick, 1988-90)
R/OE-12	Extreme Loadings of Marine Structures: Wave-Induced Structural Loading (Paulling, 1989-91)
R/OE-13	Extreme Loadings of Marine Structures: Slow Drift Motions of Offshore Platforms (Webster, 1989-91)
R/OE-17	Management of Human Error in Operations of Marine Systems (Bea, 1990-92)
R/OE-19	A Knowledge-Based Approach for Assessing the Integrity of Offshore Platforms Subjected to Seismic Loading (Ibbs/Bea, 1991-92)
R/OE-23	Development of a Numerical Model for Steep, Directional Seas (Webster, 1991-92)
R/MA-29	Economic Values of San Francisco Bay Fisheries and Water-Quality Management (Hanemann/Fisher, 1987-89)
R/MA-30	Global Economic Change, U.S. Foreign Economic Policy, and the U.S. Tuna Industry since 1949 (Scheiber, 1988-90)
R/MA-32	The Benefits and Costs of Managing Environmental Variability in the California Central Valley Chinook Salmon Fishery (Hanemann/Fisher, 1989-91)
R/MA-33	International Management Regimes, the EEZ, and the U.S. Pacific Fisheries (Scheiber, 1990-92)
R/NP-1-17H	Japan, the U.S., and Pacific Resources (Scheiber, 1987-88)
R/NP-1-18D	Legal Responses to a Rising Sea Level (Caron, 1988-89)
R/NP-1-18F	Climatic Change and Coastal Upwelling (Harte, 1988-89)

University of California, Berkeley/University of California, San Francisco

R/F-117	Endocrinology and Physiology of the Development and Survival of Salmon and Striped Bass (Bern/Cashman, 1990-91)

University of California, Davis/Bodega Marine Laboratory

R/A-65	Development of Pacific Oyster Broodstock (Hedgecock, 1987-88)

*Five-year listing; by institution of first-listed project leader, FY 1987–1992.

R/A-67 Determination of Optimum Dietary Protein, Lipid, and Carbohydrate Levels of Hatchery Produced Juvenile Sturgeon (Hung, 1987-89)
R/A-68 Endocrine Control of Molting and Reproduction in Decapod Crustacea (Chang, 1987-90)
R/A-70 Capacitation and Cryopreservation of Shrimp Sperm (Clark/Crowe, 1987-90)
R/A-73 Endocrine Stimulation and Regulation of Sturgeon Female Maturation (Moberg, 1988-91)
R/A-74 Fatal Inflammatory Bacteremia and its Association with Summer Mortality in Pacific Oysters (Hedrick, 1988-90)
R/A-77 Population Genetics of Commercial Pacific Oyster Stocks (Hedgecock, 1989-91)
R/A-78 Controlled Culture of a New Marine Model, the Sea Anemone *Nematostella vectensis* (Hand, 1990-92)
R/A-79 Improvement of Striped Bass Rearing in Hatcheries (Cech, 1990-91)
R/A-80 Hormonal Regulation of Crustacean Growth and Reproduction (Chang, 1990-92)
R/A-81 Development of Technologies for Long-Term Storage and Genetic Manipulation of Penaeoidean Eggs (Clark/Crowe, 1990-92)
R/A-82 Nutrient Cost of Reproduction for the Model Penaeid Shrimp *Sicyonia ingentis* (Conklin, 1990-91)
R/A-83 Environmental Effect on the Ovarian Development in Captive Sturgeon Broodstock (Doroshov, 1990-92)
R/A-85 Hormone Stimulation of Sturgeon Female Reproductive Maturation (Moberg, 1991-92)
R/A-88 Development and Characterization of a High Rate Biofilter for Recirculating Aquaculture Systems (Piedrahita, 1991-92)
R/F-109 New Methods in Stock Abundance Estimation (Mangel, 1987-88)
R/F-113B Age Determination of Bank Rockfish: Comparison of Traditional and Computer-Aided Techniques (Cailliet/Botsford, 1987-89)
R/F-114 Age-Specific Analysis of Rockfish Fisheries (Botsford/Henry, 1987-89)
R/F-117 Endocrinology and Physiology of Salmonid Development and Seawater Adaptation (Bern, et al., 1987-90)
R/F-118 Design and Development of a Sea Urchin Processing System (Singh, 1989-91)
R/F-119 Collagenolytic Activity in the Skeletal Muscle of Fish (Haard, 1987-90)
R/F-127 Extending Prime Quality Market Life of Seafoods (Haard/Ogrydziak, 1988-90)
R/F-133 Oxidative Metabolism of Polyunsaturated Fatty Acids in Fish; Mechanism and Physiological Function of Lipoxygenase (German, 1989-92)
R/F-135B Abalone Wasting Disease: Role of Coccidian Parasites and Environmental Factors (Hedrick, 1990-92)
R/F-136 Northern California Red Sea Urchin Fishery (Botsford/Quinn, 1990-92)
R/F-139 Edible Films to Prevent Quality Loss in Frozen Fish (Krochta, et al., 1990-92)
R/OE-7 Stability of Seafloor Under Wave Loading—Soil Model Validation and Numerical Solution (Shen, 1987-89)
R/MA-27 Forecasting Commercial Passenger Fishing Vessel Angler Participation (Johnston/Wilen, 1987-88)
R/NP-1-18A On-Board Handling of Albacore Tuna for Alternative Markets (Price, 1988-89)
R/NP-1-18G Structural Characterization of Fish by NMR Imaging (German, 1988-89)
R/NP-1-18P Sea Urchin Project (Botsford, 1989-90)

MONTEREY BAY REGION

University of California, Fresno

R/MP-42 Development of a Potential Anti-Tumor Drug from Marine Waste By-Product: Angiogenesis Inhibitor from Cartilage of Elasmobranch (Wong, 1987-90)

University of California, Santa Cruz

R/CZ-97 Assessment of Sublethal Toxic Effects in Marine Organisms by NMR Spectroscopy (Tjeerdema,1990-92)
R/F-116 Biochemical Indices of Metabolism and Growth in the California Halibut (Somero, 1987-88)
R/MP-41 Marine Natural Products in Pharmacology: Development of Leads from Marine Animals (Crews, 1987-89)
R/MP-45 Marine Natural Products in Pharmacology: Discovery and Development of New Chemotherapeutics from Marine Animals (Crews, 1989-92)

San Jose State University/Moss Landing Marine Laboratories

R/CZ-110 Seismic Risk of the Offshore San Gregorio-Hosgri Fault Zone Between Monterey and San Francisco, California (Reed, 1991-92)
R/F-113A Age Determination of Bank Rockfish: Comparison of Traditional and Computer-Aided Techniques (Cailliet/Botsford, 1987-89)
R/F-115 Description of the Larval Development of Field and Laboratory Grown California Rockfish (*Sebastes*) Species (Loeb/Cailliet, 1987-89)
R/F-129 The Biology and Fishery Potential of Hagfish (Cailliet, 1989-91)
R/F-142 The Importance of Transport Processes in Recruitment of Rockfishes (Genus *Sebastes*) to Nearshore Areas of Monterey Bay, California (Loeb, et al., 1991-92)
R/NP-1-19B Slumping and Sediment Liquefaction at the Head of Monterey Canyon (Ledbetter, 1989-90)

SANTA BARBARA REGION

University of California, Santa Barbara

R/CZ-102	Genetic Detection of Red Tide Dinoflagellates (Triplett/Prézelin, 1990-92)
R/A-84	The Development of a Vibrating Jet-and-Nozzle Apparatus for the Microencapsulation of Larval Foods (Matthys/Neushul, 1990-91)
R/A-86	Stimulation of Growth Hormone Gene Expression in Abalone: Applications for Acceleration of Growth and Improvement of Food-Conversion Efficiency and Resistance (Morse, 1991-92)
R/F-128	Evaluation and Enhancement of a Developing Claw and Whole Body Fishery for the Sheep Crab *Loxorhynchus grandis* (Kuris, 1989-91)
R/F-135A	Abalone Wasting Disease: Role of Coccidian Parasites and Environmental Factors (Kuris/Schmitt, 1990-92)
R/MP-37	GABA-Mimetic Peptides from Marine Algae and Bacteria: A New Class of Potential Diagnostic and Therapeutic Agents (Morse, 1987-89)
R/MP-38	Marine Chemistry and Pharmacology: Pharmacological Screening and Evaluation (Jacobs, 1987-89)
R/MP-44	Development of Selective Halogenation by Naturally Occurring Enzymes in Marine Organisms: A Biotechnological Approach (Butler, 1989-92)
R/MP-47	Marine Pharmeceutical Discovery Program: Pharmacology (Jacobs, 1989-92)
R/MP-49	Isolation and Characterization of Broad Spectrum Digestive Proteases from Abalone: Potential for Commercial Use in Processing Polypeptides (Groppe/Morse, 1990-91)
R/OE-6	Resistance of Offshore Structures to Collision (Armand, 1987-89)
R/NP-1-16D	California and Ocean Governance: Toward a Long-Term Strategy (Cicin-Sain, 1987-88)
R/NP-1-18K	Brood Mortality and Egg Prediction in the Tanner Crab Fishery (Kuris, 1989-90)
R/NP-1-20B	Determination of Culture Conditions, Especially Light and their Effect on Survival of the Pacific Hagfish in Captivity (Polne-Fuller, 1990-91)

LOS ANGELES REGION

University of California, Los Angeles

R/CZ-104	Detection and Monitoring of Bacteria with Molecular Probes (Chapman/Brunk, 1991-92)
R/A-71	Intestinal Nutrient Uptake and Hormone Treatment in Fish (Diamond, 1987-89)

University of California, Riverside

R/A-59	Control of Reproduction in Crustaceans (Talbot, 1987-88)

UNIVERSITY OF SOUTHERN CALIFORNIA

R/CM-42	Small Scale Mixing Processes and the Dispersion of Sewage Effluent Plumes (Jones/Washburn, USC, 1987-90)
R/RD-32	The Influence of Nursery Habitat on Production of Kelp Bass, *Paralabrax clathratus* (Holbrook, UCSB; Muscat, USC; 1987-90)
R/RD-35	Energetics of Abalone Larval Development (Manahan, USC, 1987-90)
R/CM-50	Detection and Survivability of Some Pathogenic Enterobacteria in the Region of White's Point Outfall (Iturriaga, USC, 1988-91)
R/RD-36	Crack Growth in Cathodically Protected Steel Structures (Todd, USC; Mansfield, USC; 1988-90)
R/RD-40	Development of DNA Probes for Marine Bacteria of the Genus, *Vibrio* (Shizuya, USC; Sullivan, USC; 1988-90)
R/CM-49	Strategic Planning for Urban Seaport Capacity (Heikkila, USC; 1989-90)
R/CM-55	The Physical and Biological Dynamics of Sewage Effluent Dispersion: A Synthesis (Jones, USC, 1989-90)
R/EQ-43	Genotypic Analysis in the Management of Rare or Locally Extinct Populations: A Model Species (McAlary, USC, 1989-90)
R/RD-42	Ultraviolet Detection of Zooplankton by Larval Fishes in the Marine Environment (McFarland, USC; McAlary, USC, 1989-90)
R/RD-44	A Highly Portable Miniaturized Elemental Analyzer for Oceanographic Applications (Iwanczyk, USC, Dabrowski, USC, 1989-90)
R/CE-12	BENSEM (BENthic Sampling Effectiveness Measurer)(Rimer, CSU Pomona, 1989-90)
R/CM-57	The Potential Demand for U.S. Port Services by the Maquiladora/In-Bond Plants in Northern Mexico (West, CSU Fullerton; Shabahang, Chapman University, 1989-90)(Seed Funding)
R/EQ-51	Animal Burrowing in the Sediments off the California Coastal Borderland (Fischer, USC; Gorsline, USC; Bottjer, USC, 1989-90)
R/EQ-52	Posttranslational Modifications Recorded in the Structural Proteins of the Fish Eye Lens as Indicators of Environmental Stress (McFall-Ngai, USC, 1989-90)
R/EQ-44	Physical Forcing, Particulate Fluxes and Primary Productivity in the Vicinity of an Ocean Outfall (Washburn, USC; Jones, USC; 1990-93)

R/EQ-45	The Flux of Trace Metals and Nutrients from the Seafloor in the Area Around the White's Point Sewage Outfall (Berelson, USC; Johnson, Moss Landing Marine Laboratory, 1990-93)
R/EQ-49	Temporal Evolution of Particulate Distributions in the Vicinity of an Ocean Outfall as Forced by Physical and Biological Processes (Dickey, USC, 1990-93)
R/MT-10	The Potential Demand for U.S. Port Services by the Maquiladora/In-bond Plants in Northern Mexico (West, CSU Fullerton, Shabahang, Chapman University 1991-92)
R/EQ-53	Dispersal and Gene Flow in Algae: Coupling Between the Urban-Influenced Marine Environment and Offshore Communities in Southern California (Carpenter, CSU Northridge, 1991-92)
R/EQ-50	Viruses in the Ocean Near Los Angeles (Furhman, USC, 1991-94)
R/CM-56	A Spatial-Sectoral Economic Impact Model of Seaport Development for Evaluating the Development and Resolution of Intra-Community Conflicts (Heikkila, USC; West, CSU Fullerton, 1991-94)

SAN DIEGO REGION

San Diego State University

R/CZ-79	Maintenance of Entrance Channels of Coastal Lagoons and River Mouths (Chang/Stow, 1987-89)
R/CZ-82	Artificial Coastal Wetlands: How Well Do They Duplicate Natural Ecosystem Functions? (Zedler, 1987-89)
R/CZ-87	Wastewater Wetlands: Pulsed Discharges to Protect Coastal Water Bodies (Zedler/Gersberg, 1989-91)
R/CZ-106	Methods to Improve Restoration of Pacific Estuarine Ecosystems (Zedler, 1991-92)
R/CZ-108	Mitigating Loss of Eelgrass: Providing Sufficient Genetic Diversity (Williams, 1991-92)
R/F-138	Estimating Growth and Mortality Rates for Red and Purple Sea Urchins (Ebert, 1990-91)
R/OE-18	Salinity Powered Distillation of Freshwater from Seawater Using Plastic Sheet Heat Exchangers (Lowrey, 1990-92)

University of California, San Diego/Scripps Institution of Oceanography

R/CZ-76	Study of Extreme Coastal Sea Level (Cayan/Flick, 1987-88)
R/CZ-77	Prediction of Nearshore Sediment Transport Using a Model for Fluid-Sediment Coupling (Inman, 1987-89)
R/CZ-90	Southern California Waves: Model Verification and Utilization (Guza, 1989-92)
R/CZ-92	Scales of Variability of Sewage-Influenced Water Column Properties in the Southern California Bight (McGowan/Mullin, 1989-91)
R/CZ-94	Paralabrax as a Model for Predicting Effects of Ocean Warming (Rosenblatt, et al., 1990-92)
R/CZ-95	Ultraviolet Radiation Flux in the Southern California Bight and Adaptation by Individual Phytoplankton Taxa (Mitchell, 1990-91)
R/CZ-96	Internal Hydraulic Control of Buoyant Inflows to Californian Estuaries (Largier/Armi, 1990-91)
R/CZ-98	Phenolic Compounds in Seawater: Rates and Mechanisms of Biodegradation (Carlucci, 1990-92)
R/CZ-103	Geochemical Control of Toxicant Release Rates from San Diego Bay Sediments (Reimers, 1991-92)
A/S-3	Remote Sensing in Operational Fisheries: A Tool for the Utilization and Management of a Renewable Resource (Simpson, 1990-91)
R/F-111	Correlation Between the Whiting Fishery and the Biomass of Whiting Food (Mullin, 1987-88)
R/F-125	Pre-Exploitation Abundances of Important Large Recreational and Commercial Fishes (Dayton/MacCall, 1988-89)
R/F-132	Immunological Identification of Larval Fish Prey (Ohman, 1989-91)
R/F-143	Variation in Coastal Pelagic Fish Populations Over the Past Millennium as a Response to Global Climatic Change and Biological Interaction (Baumgartner/Soutar, 1991-92)
R/MP-39	Marine Chemistry and Pharmacology Program: Development of New Drug Leads from Marine Plants and Gorgonian Corals (Fenical, 1987-89)
R/MP-40	Marine Chemistry and Pharmacology Program: Development of New Pharmaceutical Agents from Marine Invertebrates (Faulkner, 1987-89)
R/MP-46	Marine Pharmaceutical Discovery Program: Chemistry Component A (Faulkner, 1989-92)
R/MP-48	Marine Pharmaceutical Discovery Program: Chemistry Component B (Fenical, 1989-92)
R/OE-3	Numerical Bathymetry in Shallow Water (Seymour, 1987-88)
R/OE-4	Acoustic Doppler System for Directional Wave Measurements (Lowe/Guza, 1987-89)
R/OE-8	Seismic Effects on Sheet-Pile Walls in Waterfront Structures (Nogami, 1988-90)
R/OE-10	"Black Smoker" Vents for Ocean Thermal Power (Anderson, 1987-90)
R/OE-14	Improved Fatigue Life for Moorings (Seymour, 1989-92)
R/OE-15	Advanced Development of a 3-D Ultrasonic Imaging System (Jaffe, 1989-91)
R/OE-16	Repair of Damaged Offshore Structural Steel Members Using Grouting (Ricles/Benson, 1990-92)
R/OE-24	Acoustic Sensing of Pelagic Fish Stocks (Jaffe, 1991-92)
R/OE-25	Improved Utilization and Management of the U.S. Exclusive Economic Zone (EEZ) Using Advanced Satellite and Geographic Information Systems Technologies (Simpson, 1991-92)
R/MA-31	Deterring Oil Spills: Optimal Policies (Carson/Groves, 1989-90)
R/NP-1-17A	Measuring Overwash on a Barrier Island (Guza, 1988-90)
R/NP-1-17B	Temporal Change of Deep-Sea Hydrothermal Vent Communities (Hessler, 1987-89)

R/NP-1-18B	Functional Morphology of the Lateral Line System in Two Species of Commercially Important California Flatfishes: Ontogeny and Asymmetry (Webb, 1988-89)
R/NP-1-18M	Genetic Divergence Between Reproductive Types in Northern and Southern Populations of the Edible Goose-Barnacle *Policipes* (Newman, 1989-90)

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